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MODELLING OF RISK AVERSION COEFFICIENTS AND RISK PREMIUM FOR PADDY FARMER: A CASE STUDY IN THE COASTAL AREA OF ANDHRA PRADESH

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ABSTRACT

Agricultural farmers face lot of hardships to obtain a satisfactory yield in terms of revenue due to unpredictable environmental conditions leads to risk aversion. An attempt is made here to quantify such risk which can be used in future for formulating various protective policies to farmers. A multi criteria technique is applied to calculate various risk coefficients. A final case study is done to evaluate risk coefficients. Formulation of the regression equation is done to calculate proportional risk premiums.

KEYWORDS: Farmers, Risk Aversion, Multi Criteria Technique & Downside Risk

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1. INTRODUCTION

In India, agricultural risks are affected by a variety of factors, ranging from climate variability and change, frequent natural disasters, uncertainties in yields and prices, weak rural infrastructure, imperfect markets and lack of financial services including limited span and design of risk mitigation instruments such as credit and insurance. These factors not only endanger the farmer's livelihood and incomes but also undermine the viability of the agriculture sector and its potential to become a part of the solution to the problem of endemic poverty of the farmers and the agricultural labor. The criticality of agriculture in the rural transformation and the national economy seen along with its structural characteristics requires substantial governmental and financial sector interventions not only to ensure household food and nutritional security of the farming community but also to generate savings and investments in this grossly underfunded sector. Increasing the effectiveness of instruments for pooling, sharing and transfer of risks, enhancing the coping capabilities of the farmers and other mitigation measures will make farming attractive. Hence, exploration of suitable metrics for risk will help to devise suitable plan for supporting farm community.

Risk is present in all agricultural management decisions as a result of price, yield and resource uncertainty. Generally the agricultural producers are risk averse in the arrow Pratt (1964) [1] sense, the risk

aversion coefficient is an indicator for expressing risk.

Definition of risk is both different and broader. Risk, as we see it, refers to the likelihood that we will receive a return on an investment that is different from the return we expected to make. Thus, risk includes not only the bad outcomes, i. e., returns that are lower than expected, but also good outcomes, i. e., returns that are higher than expected. In fact, the former can be referred as downside risk and the latter is upside risk, but many consider downside risk in agricultural production.

Down side risk can arise from two different causes that, in some situations, can operate in unison to magnify the risk that the consequences of some risky choice will be less than foreseen at the outset. First, Downside risk can occur when decisions are made under assumed certainty, based on 'norm' or 'best estimate' of the consequences. The risk here arises if the distribution of outcome is negatively skewed so that the mode is above the mean. Second, Downside risk may also arise when an outcome depends on non-linear interactions between a number of uncertain quantities. "Thus Downside risk is the greater probability that the outcome will fall below the mode than above it". Downside risk is calculated by the difference between the central tendency (Expected Mean, Mode) and the actual yield.

Risk premium (RP) is the minimum amount of money by which the expected return on a risky asset must exceed the known return on a risk-free asset in order to induce an individual to hold the risky asset rather than the risk-free asset. It is positive if the person is risk averse sometimes it is necessary to compute the proportional risk premium (PRP) representing the proportion of the expected payoff of a risky prospect that the farmers would be willing to pay to trade away all the risk for a sure thing, and is defined as, PRP = Risk premium (RP) /Expected value (E) (Hardakar 2000) [2], i. e., the more risk averse is the decision maker or the more uncertain the risky prospect, the higher will be the PRP.

To determine risk aversion coefficients, adopted a methodology based on multi attribute utility theory (MAUT) (Gomez-2003 (3), so the MAUT consists of aggregating the different points-of-view into a unique function which will be optimized, MAUT has not been widely used in agricultural applications. Probably the seeming complexity of the method has discouraged potential analysts. Similarly, the multiplicative form of the MAUT function can be avoided if it is judged to be adequate to use normalized weights to combine the attribute utilities. Total Net Profit or Total Net Return is the gross farm income minus the total farm expenditures. Total Net Return is the economic incentive to the farmers and is an important motivating factor to the farmers to increase the paddy yield, risk is measured as the variance of the TNP and downside risk is measured as skewness of TNP.

The profit from farming over number of years follows an asymmetrical distribution, hence the moments about mean, variance and skewness describes the behaviour of expected profit.

Analytic Hierarchy Process (AHP) is one of Multi Criteria decision making method that was originally developed by Prof. Thomas L. Saaty, [4]. In short, it is a method to derive ratio scales from paired comparisons. The input can be obtained from actual measurement such as price, weight, etc. or from subjective opinion such as satisfaction feelings and preference. AHP allow some small inconsistency in judgment because human is not always consistent. The ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value.

The desire of farming does not continue unless income generates, the expected profit influenced by various factors which cannot be exactly determined. Hence the determination of profit is determined on asymmetrical distribution function. The parameters of such distribution are influenced by the attitudes and beliefs of the agents of the farming

community. An attempt is made here to determine the relative weightage of such parameters of the distribution by AHP method. The priorities of parameters based on AHP scale (Saaty scale) are obtained by interacting with the agricultural field officer and farmers and such scales are averaged. Subsequently AHP is performed to determine the weightages.

The objective of the study is to determine the Proportional risk premium of the farmer who are always under distress due to unforeseen environmental condition

This paper presents a methodology based on Multiple Criteria Mathematical Programming to obtain Absolute Risk aversion coefficients, absolute Downside Risk Aversion Co-efficient and Risk premium for Total Net profit (TNP) of the paddy farmers.

The paper presented is organised as follows:

Section-2 describes literature review,

Section-3 presents terminology used and definitions,

Section-4 presents objectives,

Section-5 describes the methodology,

Section-6 presents case study,

Section-7 presents results and discussion and

Section-8 presents conclusions.

2. LITERATURE REVIEW

Pratt (1964) and Arrow (1965) [5] paid attention to one key elements of decision theory, i. e., the measure of risk aversion of the economic agents. The risk premium is computed by Chavas (1996) [6] and Groom (2008) [7] by using Risk aversion coefficients (Ra and Da).

In the field of agriculture the farmers community exhibit DARA in line with most related studies, such as Wiens (1976) [8], Binswanger (1980, 1981) [9, 10], Lins et al. (1981) [11], Hamal and Anderson (1982) [12], Chavas and Holt (1990, 1996) [13], Saha et al. (1994) [14], Feinerman and Finkelshtain (1996) [15], Bar-Shira et al. (1997) [16] and Saha (1997) [17], Gomez(2003). The approximation of the additive formulation to the real multi-attribute function, supported by several empirical studies, is explained by some authors on the basis of psychological reasons (Dawes and Corrigan, 1974 [18], Einhornand Hogart, 1975 [19], Dawes, 1979 [20]). The additive function yields extremely close approximations to the hypothetical true function. Although the conditions for the assumption of an additive utility function are somewhat restrictive, Edwards (1977) [21], Farmer (1987) [22] and Huirne and Hardaker (1998) [23] have shown that even when these conditions are not satisfied. The risk coefficient can be interpreted as the percentage change in marginal utility caused by each monetary unit of gain or loss (Raskin and Cochran, 1986) [24].

For determine Absolute risk aversion coefficient (Ra) and Downside Risk aversion coefficient (Da) are used in expected utility theory, but in reality, farmers actual net profit is less than the Expected Net Profit (ENP) when applied to field data, this is due to unknown Weather conditions, inadequate water availability, soil potential, fertilizers used so it is opined that the profit function distribution of farmers exhibit right skewness (downside risk aversion). G. Donoso 2014

[25] developed a decision frame work in finding optimal portfolio of assets using third order Taylor expansion by incorporating risk aversion and downside risk aversion and Gomez (2003) developed a model to determine MAUT Risk aversion coefficients, by taking the first two moments (E-V) (mean-variance) and their weights based on farmers opinion, for decision aiding, Gomez (2003) has not considered the relative importance and interaction among the attributes in determining the weight.

In order to satisfy the reality, an attempt is made to bridge the gap by incorporating downside risk aversion and as well as introducing flexibility by AHP in determining the weights to find proportional risk premium.

3. TERMINOLOGY USED

Abs = Absolute

AHP = Analytic Hierarchy Process

ANP = Actual Net Profit

AVG = Average

CARA = Constant Absolute Risk Aversion

D_a = Downside Risk aversion coefficient

DARA = Decreasing Absolute Risk coefficiency

E = Expected value also termed as mean value, i. e., Grand average of Total net profit

ENP = Expected Net Profit (Data taken from agricultural experts and farmers)

EUT = Expected Utility Theory

(f_j^*) = Ideal objective

(f_{j*}) = Anti-ideal objective

IARA = Increasing absolute risk aversion

j = Decision attributes $\vec{X}$ (e. g. crop area)

$K_1 = TNP^* – TNP_*$,

$K_2 = VAR_* – VAR^*$

$K_3 = SKW^* – SKW_*$

K_i is the difference between the ideal (f_j^*) and the anti-ideal (f_{j*})

MAUT = Multi Attribute Utility Theory

MCDM = Multi Criteria Decision Making

n = Number of decision attributes

NR = Net Return

PRP = Proportional Risk Premium

R_a = Risk aversion coefficient

RP = Risk Premium

Skew = Skewness

SKW^* is the maximum variance of TNP per acre for the given period

SKW_* is the minimum variance of TNP per acre for the given period

TNP = Total Net Profit

TNP(X) is total net profit per acre of a paddy field

TNP^* is the maximum total net profit per acre for the given period

TNP_* is the minimum total net profit per acre for the given period

U = Farmer utility function

u_2 = Measure of second moments of the distribution

u_3 = Measure of third order moments of the distribution

VAR = Variance

VAR_* is the minimum variance of TNP per acre for the given period

VAR^* is the maximum variance of TNP per acre for the given period

W = Wealth of the farmer

W_0 = Initial wealth of the farmer

w_1 is weight for TNP

w_2 is the weight for of risk

w_3 is the weight for of Downside risk

3.1 Importance of Risk Aversion Coefficients R_a and Downside Risk Aversion Coefficient D_a and its Significance

Pratt proposed two indicators for determining risk aversion coefficients. The first is the absolute risk aversion coefficient (R_a). This coefficient is calculated mathematically as follows:

$$R_a(W) = \frac{U^{II}(W)}{U^{I}(W)} \text{ and } R_a(W) = R_a(X) = -\frac{U^{II}(X)}{U^{I}(X)}$$

The coefficient R_a decreases as monetary value increases we have decreasing absolute risk coefficient (DARA). Alternatively, if the coefficient increase under the set of circumstances we have an increasing absolute risk aversion (IARA). Finally, if the coefficient does not change across the monetary level, the decision maker exhibits constant absolute risk aversion (CARA), which implies the level of argument of the utility function does not affect his or her decisions under

uncertainty.

3.2 Downside Risk Averse

For Downside risk aversion there is an unanimity to define Downside risk averse in the expected utility model by a positive third derivative of the utility function ($U^{III} > 0$), The measure of absolute down side risk aversion is given by

$$D_a(W) = -\frac{U^{III}(W)}{U^{I}(W)}.$$

3.3 Risk Premium (RP)

Thus the risk premium RP, which measures the willingness to pay of a decision maker to eliminate the risk associated with profit.

The R_a and D_a coefficients can then be used to compute the risk premium, denoted RP. Assuming that the farmer is concerned by the first three moments of the distribution only, we have $RP = \frac{R_a u_2}{2} - \frac{D_a u_3}{6}$, where u_2 and u_3 are measure of the second and third order moments of the distribution. If RP > 0 means that the farmer is characterized by a positive willingness to pay to be insured against risk and risk averse.

3.4 AHP

The AHP generates a weight for each evaluation criterion according to the decision maker’s pairwise comparisons of the criteria. The higher the weight, the more important the corresponding criterion. Next, for a fixed criterion, the AHP assigns a score to each option according to the decision maker’s pairwise comparisons of the options based on that criterion. The higher the score, the better the performance of the option with respect to the considered criterion. Finally, the AHP combines the criteria weights and the option scores, thus determining a global score for each option, and a consequent ranking. The global score for an individual farmer a given option is a weighted sum of the scores it obtained with respect to all the criteria. These scores are used as weights in the paper.

3.5 MAUF (Multi Attribute Utility Function)

The additive MAUF (multi attribute utility function) can be expressed as:

$$U = \sum_{j=1}^{n} w_j \frac{f_j(\vec{X}) - f_{j*}}{f_j^* - f_{j*}} \tag{1}$$

Each attribute j is defined as a mathematical function of decision variables $\vec{X}$ (e. g. crop area); $f_j = f_j(\vec{X})$. These attributes are proposed a priori as the most relevant decision-making criteria that are utilised by farmers (usually profit, risk, skewness, etc.).

Thus, the utility function (1) is normalized by the difference between the ideal (f_j^*) and the anti-ideal (f_{j*}) of the different objectives, and choosing the mathematical expression of the attributes as their utility function, $f_j(X)$ minus the anti-ideal $f_{j*}(X)$.

4. OBJECTIVES

- To Determine Proportional Risk premium.
- Generalized equation to compute Proportional Risk premium.

5. METHODOLOGY

Step-1: Proportional risk premium calculation

5.1 Formulation of Multi Attribute Utility Function

As per the farmer's perspective TNP is an important factor for the continuation of farming. Hence a multi attribute utility function is built on TNP, its variance and its skewness, the prioritizing (weightage) of TNP, skewness and variance is done by an AHP technique after obtaining expert opinion.

The additive utility function mentioned at (1) can be reformulated as follows:

$$U = w_1 \frac{TNP(\vec{X}) - TNP_*}{TNP^* - TNP_*} + w_2 \frac{VAR_* - VAR(\vec{X})}{VAR_* - VAR^*} + w_3 \frac{SKW(\vec{X}) - SKW_*}{SKW^* - SKW_*} \quad (2)$$

The proposed MAUT and EUT approach are reconciled in step 2.

Step-2: Framing expected utility of Total net profit (E[U(TNP)]) expression by Taylor series of first three moments.

To calculate the Arrow-Pratt risk aversion coefficients (R_a and R_r) and Downside risk averse coefficient (D_a) from the former expression. Assuming that the expected utility of the TNP can be approximated by the Taylor series of the first three moments, mean, variance and skewness the decision-maker's utility function can be expressed as follows:

$$E[U(TNP)] = E(TNP) - \frac{\lambda \sigma^2_{TNP}}{2} + \frac{\gamma SK_{TNP}}{6} \quad (3)$$

Knowing that E(TNP) is equal to average TNP and λ is the R_a coefficient (Pratt, 1964) and γ is the D_a coefficient, the above expression becomes:

$$E[U(TNP)] = TNP - \frac{R_a(TNP)}{2}.VAR + \frac{D_a(TNP)}{6} SKW \quad (4)$$

Step-3: Reconciling EUT and MCDM and determination of R_a and D_a coefficients

From expressions (2) and (4), (The possibility of joining EUT and MCDM had been already pointed by Romero et al. (1988, p. 275) [26] in the context of compromise-risk programming.

Where K_i is the difference between the ideal (f_j^*) and the anti-ideal (f_{j*})

$K_1 = TNP^* – TNP_*$, $K_2 = VAR_* – VAR^*$, $K_3 = SKW^* – SKW_*$

$$U = w_1 \frac{TNP(\vec{X}) - TNP_*}{K_1} + w_2 \frac{VAR_* - VAR(\vec{X})}{K_2} + w_3 \frac{SKW(\vec{X}) - SKW_*}{K_3} \tag{6}$$

$$U = \left\{ \frac{w_1}{K_1} \left[\left(TNP(\vec{X}) - \frac{w_2 k_1}{w_1 k_2} VAR(\vec{X}) + \frac{w_3 k_1}{w_1 k_3} SKW(\vec{X}) \right) \right] \right.$$

$$\left. - TNP_* + \frac{w_2 k_1}{w_1 k_2} VAR_* - \frac{w_3 k_1}{w_1 k_3} SKW_* \right\} \tag{7}$$

From expression (7) we see that it is possible to obtain the risk aversion coefficients (Ra and Da) by similarity with expression (4).

$$R_a(W) = R_a(TNP) = \frac{2 w_2 K_1}{w_1 K_2} \text{ and } D_a(W) = D_a(TNP) = \frac{6 w_3 K_1}{w_1 K_3} \tag{8}$$

($W = W_0 + TNP$, where W_0 is initial wealth and TNP is Total net profit, and there is asset integration then it can be proved that $R_a(W) = R_a(TNP)$ (asset integration assumption Hardakar (2000))

$R_a(W) = R_a(TNP)$

The risk premium R, which measures the willingness to pay of a decision maker to eliminate the risk associated with profit.

$$RP = \frac{R_a u_2}{2} - \frac{D_a u_3}{6} \tag{9}$$

where u_2 and u_3 are variance and skewness of TNP respectively.

Proportional Risk Premium = RP/E.

5.1.1 Constraints in the Models

To estimate individual farmers TNP, VAR and SKW we needed historical TNP data from each individual farm, data which are not normally available (farmers usually do not keep accounting records). So for feeding the models the data required were obtained from the survey developed in the irrigated area studied and from the Andhra Pradesh Agricultural Hand book.

6. CASE STUDY

A survey of 30 paddy farmers selected at random was used to gather the necessary data to build the models (crop area, costs, yields and constraints).

- Data taken from paddy farmers for different wealth based on their production.
- Data taken per crop for RABI and KHARIFF season.
- Data collected from different areas of Paddy field farmers for a period of eight years (2010 to 2017); (field data and Andhra Pradesh agriculture Handbooks 2010-2017)

- Weight associated with the corresponding objectives were taken from the agricultural officers, farmers and agricultural experts.
- Finally computed Ra, Da and PRP for farmers, by using the formula (8) & (9)
- The values of Ra, Da and PRP are analysed in Table 2 to Table 7 respectively.
- Results and Analysis of the risk aversion coefficients.
- Model Calculation for finding Proportional Risk Premium (PRP).

For a Farmer whose expected value (i. e., Grand Average of total net profit) is Rs. 10,226, Field Data is collected for computing relative risk premium for a paddy farmer based on total net profit for a period of eight years, it is divided into four groups as shown in table 1, the average, variance and skewness are calculated and tabulated as shown in Table 1 and their total variance $u_2 = 17332.9$, total skewness $u_3 = -0.17$ are calculated and their associated weights is given as $w_1 = 0.1$, $w_2 = 0.8$, $w_3 = 0.1$

Table 1

Year	NP in KHARIFF (Rs.)	NP in RABI (Rs.)	AVG	VAR	SKEW
2010	10300	10200	10330	11266.67	–0.24082
2011	10370	10450			
2012	10125	10250	10176	3589.583	0.561027
2013	10130	10200			
2014	10000	10050	10172	30491.67	0.10804
2015	10360	10280			
2016	10080	10190	10225	13633.33	–0.40707
2017	10280	10350			

Weights are computed by using AHP Priority Calculator (Klaus D. Goepel**)**

Steps for developing the weights (w_1, w_2, w_3) for the criteria are as follows:

The Comparison matrix is as follows:

We have 3 by 3 reciprocal matrix from paired comparison as shown in table

Table

	TNP	Risk	Downside Risk
TNP	1	0.1111	1
RISK	9	1	8
DOWNSIDE RISK	0.5	0.125	1
SUM	10.5	1.2361	11

Then we divide each element of the matrix with the sum of its column, we have normalized relative weight. The sum of each column is 1.

Table

	TNP	Risk	Downside Risk
TNP	0.095238	0.089879	0.181818
RISK	0.857143	0.808989	0.72723
DOWN SIDE RISK	0.047619	0.101124	0.090909
SUM	1	1	1

The normalized principal Eigen vector can be obtained by averaging across the rows and the weights values are rounded as shown below,

$$w = \frac{1}{3}\begin{bmatrix} 0.366935 \\ 2.393405 \\ 0.239652 \end{bmatrix} = \begin{bmatrix} 0.122312 \\ 0.797802 \\ 0.079884 \end{bmatrix}$$

Consistency Ratio CR = 7.7%, CR value is less than 10% (acceptable).

Thus, experts' subjective evaluation about the weights preference is consistent.

Finally the weights are rounded as follows:

TNP = 0.122312 = 0.12 = w_1

RISK = 0.797802 = 0.80 = w_2

Downside risk = 0.08 = 0.10 = w_3

AHP Scale: 1-Equal Importance, 3-Moderate importance, 5-Strong importance, 7-Very strong importance, 9-Extreme importance (2, 4, 6, 8 values in-between).

K_1 = MAX AVG – MIN AVG = 10330 – 10172.2 = 157.5

K_2 = MIN VAR – MAX VAR = 3590 – 30492 = –26902

K_3 = MAXSKW – MIN SKW = 0.561 – (–0.407) = 0.968

So from Eq.(8)

Abs $R_a = \frac{2w_2K_1}{w_1K_2}$ = (2 * 0.8 * 157)/(0.12 * (–26902) = 0.077 (11)

$D_a = \frac{6w_3K_1}{w_1K_3}$ = (6 * 0.08 * 157)/(0.12 * 0.968) = 648 (12)

Form the given data Risk premium is calculated from Eq. (9) as follows

$RP = \frac{R_a u_2}{2} - \frac{D_a u_3}{6}$ from Eq.(9).

Sub (11) and (12) in (10) we get RP = 685.

Therefore the Proportional Risk premium is RP/E = 685/10226 = 0.0669.

7. RESULTS AND DISCUSSIONS

Similarly Data is obtained for 100 farmers and computed farmers risk aversion coefficients R_a, D_a and PRP are tabulated.

- Data is classified into five groups based on the AHP weights, they are tabulated in Table 2, 3, 4, 5 and 6 respectively, this assists in observing the influence of risk aversion coefficients, PRP and TNP of the farmers

within the group.

- From Table 2 to Table 6, shows that the minimization of risk is the most important objective with an average weighted importance of 60%, followed by maximization of total net profit with an average weighting of 26%. The objectives of the maximization of downside risk with relative weight of 14% respectively,
- From Table 2 to table 6 we can see the Ra and Da achieve relatively high values, with an average of 0.0515 and 321, this values are relatively high when compared with G. Lien (2000) [27] is due to the estimations based on two different scientific paradigms. Where as R_a values are nearer with Gomez (2003) MAUT risk aversion coefficients.
- Results stating the farmers in this entire group are risk averse same as the arrow – Pratt (1964) sense.

Table 2: (Group-A)

Farmer	Grand AVG TNP (Rs.)	w_1	w_2	w_3	R_a	D_a	RP (Rs)	PRP
1	10226	0.1	0.8	0.1	0.093673	976.139	741	0.072506
2	10762	0.1	0.8	0.1	0.1260923	1831.44	1607	0.149357
3	11232	0.1	0.8	0.1	0.0581635	614.187	704	0.062726
4	11751	0.1	0.8	0.1	0.1842051	492.134	3409	0.290131
5	12301	0.1	0.8	0.1	0.2684528	586.133	3191	0.259421
6	12733	0.1	0.8	0.1	0.0492199	380.971	714	0.056137
7	13244	0.1	0.8	0.1	0.0413883	272.219	356	0.02692
8	13812	0.1	0.8	0.1	0.1146539	476.32	1445	0.104627
9	14304	0.1	0.8	0.1	0.216555	536.113	1602	0.112013
10	14765	0.1	0.8	0.1	0.0721629	323.445	684	0.046337
11	15261	0.1	0.8	0.1	0.2708333	310.85	1389	0.091059
12	15649	0.1	0.8	0.1	0.0274813	88.7746	170	0.010868
13	16282	0.1	0.8	0.1	0.1422748	671.441	1366	0.083939
14	16738	0.1	0.8	0.1	0.1723342	4019.95	1312	0.07839
15	17217	0.1	0.8	0.1	0.1673375	504.793	1870	0.108633
16	17758	0.1	0.8	0.1	0.0771918	501.797	1008	0.056781
17	18233	0.1	0.8	0.1	0.2413938	687.244	2366	0.129793
18	18780	0.1	0.8	0.1	0.0937367	590.639	1362	0.072561
19	19254	0.1	0.8	0.1	0.2005037	472.779	2199	0.114242
20	19772	0.1	0.8	0.1	0.1396664	253.837	1431	0.072413
AVG	15003	0.1	0.8	0.1	0.137866	729.56	1446	0.099943

Table 3: (Group-B)

Farmer	Grand AVG TNP (Rs)	w_1	w_2	w_3	R_a	D_a	RP (Rs)	PRP
21	21203	0.2	0.7	0.1	0.0494602	148.406	409	0.019295
22	21233	0.2	0.7	0.1	0.0226523	203.813	276	0.013028
23	21317	0.2	0.7	0.1	0.0477926	249.375	410	0.019266
24	21317	0.2	0.7	0.1	0.0322867	161.725	339	0.015915
25	21271	0.2	0.7	0.1	0.0376447	299.786	538	0.0253
26	21312	0.2	0.7	0.1	0.1058641	327.625	816	0.038312
27	21220	0.2	0.7	0.1	0.0421617	313.216	371	0.01749
28	21208	0.2	0.7	0.1	0.0511161	102.808	275	0.012977
29	21291	0.2	0.7	0.1	0.0174208	137.221	124	0.005848
30	21269	0.2	0.7	0.1	0.1635593	220.959	1607	0.075601
31	21768	0.2	0.7	0.1	0.0718469	690.147	702	0.032262
32	21825	0.2	0.7	0.1	0.024812	167.644	229	0.010503
33	21730	0.2	0.7	0.1	0.0401933	206.234	250	0.011519
34	21795	0.2	0.7	0.1	0.0482197	180.096	451	0.020701

35	21795	0.2	0.7	0.1	0.0797947	148.666	725	0.033291
36	22238	0.2	0.7	0.1	0.1137844	81.4881	836	0.037636
37	22189	0.2	0.7	0.1	0.0363694	176.515	321	0.014506
38	22286	0.2	0.7	0.1	0.0390531	382.466	537	0.02413
39	22291	0.2	0.7	0.1	0.040789	255.762	567	0.025475
40	22238	0.2	0.7	0.1	0.1067929	172.215	1009	0.045414
AVG	21639	0.2	0.7	0.1	0.0585807	231.308	540	0.024923

Table 4: (Group-C)

Farmer	Grand AVG TNP (Rs)	w_1	w_2	w_3	R_a	D_a	RP (Rs)	PRP
41	23253	0.3	0.6	0.1	0.0804468	289.189	829	0.03566
42	23214	0.3	0.6	0.1	0.1312073	197.032	642	0.02767
43	23203	0.3	0.6	0.1	0.0334612	118.162	319	0.013752
44	23168	0.3	0.6	0.1	0.0092934	99.1238	84	0.003635
45	23280	0.3	0.6	0.1	0.0360117	190.917	438	0.018815
46	23242	0.3	0.6	0.1	0.0119408	51.9873	146	0.006324
47	23219	0.3	0.6	0.1	0.0354327	111.403	338	0.014586
48	23271	0.3	0.6	0.1	0.0214072	106.025	161	0.00692
49	23263	0.3	0.6	0.1	0.0115393	125.588	145	0.006256
50	23215	0.3	0.6	0.1	0.0162057	200.853	208	0.008979
51	23736	0.3	0.6	0.1	0.0308003	151.311	223	0.009436
52	23728	0.3	0.6	0.1	0.0187947	161.858	121	0.005133
53	23749	0.3	0.6	0.1	0.0282011	138.923	319	0.013439
54	23783	0.3	0.6	0.1	0.0656204	209.08	708	0.02978
55	23724	0.3	0.6	0.1	0.0157194	100.331	120	0.0051
56	23756	0.3	0.6	0.1	0.018393	261.733	197	0.008323
57	23794	0.3	0.6	0.1	0.0241447	162.169	268	0.011277
58	23676	0.3	0.6	0.1	0.0518928	266.727	497	0.021011
59	23704	0.3	0.6	0.1	0.0152929	109.545	159	0.00671
60	23723	0.3	0.6	0.1	0.0525504	93.6692	506	0.021332
AVG	23484	0.3	0.6	0.1	0.0354178	157.281	321	0.013707

Table 5: (Group-D)

Farmer	Grand AVG TNP (Rs)	w_1	w_2	w_3	R_a	D_a	RP (Rs)	PRP
61	24179	0.3	0.5	0.2	0.0213432	339.983	171	0.007081
62	24338	0.3	0.5	0.2	0.0245361	812.583	331	0.013605
63	24220	0.3	0.5	0.2	0.0272018	397.232	414	0.017116
64	24302	0.3	0.5	0.2	0.0220577	220.61	360	0.014829
65	24288	0.3	0.5	0.2	0.0143211	141.115	160	0.006624
66	24225	0.3	0.5	0.2	0.0231114	192.658	206	0.008536
67	24266	0.3	0.5	0.2	0.0159514	216.615	170	0.007037
68	24213	0.3	0.5	0.2	0.0669225	296.839	941	0.038883
69	24266	0.3	0.5	0.2	0.0299982	263.357	255	0.010524
70	24199	0.3	0.5	0.2	0.0353975	457.208	331	0.013692
71	24761	0.3	0.5	0.2	0.0509636	345.051	517	0.020883
72	24805	0.3	0.5	0.2	0.0107746	181.798	53	0.002169
73	24809	0.3	0.5	0.2	0.0071647	63.4965	54	0.002201
74	24768	0.3	0.5	0.2	0.0257599	253.536	245	0.009911
75	24697	0.3	0.5	0.2	0.0242257	225.822	221	0.008964
76	24721	0.3	0.5	0.2	0.0846495	417.897	938	0.037977
77	24761	0.3	0.5	0.2	0.0405915	247.817	360	0.014578
78	24740	0.3	0.5	0.2	0.0345526	318.709	449	0.018169
79	24701	0.3	0.5	0.2	0.0224156	374.782	161	0.006556
80	24747	0.3	0.5	0.2	0.060156	351.056	401	0.01624
AVG	24500	0.3	0.5	0.2	0.0321047	305.908	337	0.013779

Table 6: (Group-E)

Farmer	Grand AVG TNP (Rs)	w_1	w_2	w_3	R_a	D_a	RP (Rs)	PRP
81	25245	0.3	0.5	0.2	0.0046742	166.152	68	0.002708
82	25276	0.4	0.4	0.2	0.0127761	218.533	168	0.006675
83	25276	0.4	0.4	0.2	0.0075761	141.5	100	0.003974
84	25263	0.4	0.4	0.2	0.0048275	213.986	49	0.001949
85	25190	0.4	0.4	0.2	0.0052324	191.672	44	0.001764
86	25258	0.4	0.4	0.2	0.0195681	147.097	266	0.010549
87	25263	0.4	0.4	0.2	0.024476	160.848	127	0.005037
88	25245	0.4	0.4	0.2	0.0087433	234.56	93	0.003703
89	25190	0.4	0.4	0.2	0.0083973	287.184	45	0.001811
90	25278	0.4	0.4	0.2	0.0392558	94.1895	505	0.020003
91	25691	0.4	0.4	0.2	0.0141798	98.4366	76	0.002981
92	25713	0.4	0.4	0.2	0.0104528	123.799	65	0.002543
93	25687	0.4	0.4	0.2	0.009928	97.5613	78	0.003073
94	25792	0.4	0.4	0.2	0.005206	140.01	46	0.001809
95	25823	0.4	0.4	0.2	0.0044129	170.479	61	0.002395
96	25689	0.4	0.4	0.2	0.0201669	287.91	185	0.007216
97	25698	0.4	0.4	0.2	0.0166255	143.972	98	0.003846
98	25669	0.4	0.4	0.2	0.0149398	98.2602	116	0.004556
99	25730	0.4	0.4	0.2	0.008371	566.961	61	0.002397
100	25759	0.4	0.4	0.2	0.0100452	101.698	154	0.00599
AVG	25486	0.395	0.405	0.2	0.0124927	184.24	120	0.004749

7.1 Analysis of the Global Structure of PRP

The mathematical programming method proposed in this paper allows the calculation of the PRP for a particular level of TNP. Thus, we cannot obtain the value of these value for other levels of TNP than the observed ones since this would require the elicitation of the farmer's utility function, since it is important to determine how these PRP change with the level of wealth in order to evaluate the impact of alternative agricultural policies, we can regress PRP on the level of TNP for all farmers. The regression models, PRP = f(TNP) considered were linear, logarithmic, we then chose the model with the highest R^2. The regression analysis of the risk aversion coefficients basis on TNP values revealed that, in the case of PRP the best fit was obtained by the following logarithmic formulations:

The regression equation is

PRP = 1.631 – 0.1603. Ln(TNP)

(R^2 = 0.54; slope significant at the 99% level)

Evolution of Risk Attitudes Based on TNP

Table 7

Group	A	B	C	D	E
AVG Ra	0.139	0.05	0.03542	0.032105	0.012566
AVG Da	729	483.55	157.281	305.9083	184.2404
AVG PRP	0.10	0.02	0.01371	0.013779	0.005085
AVG TNP (Rs)	10,000-20,000	20,000-22,000	22,000-23,000	23,000-25,000	25,000-26,000

The evolution of risk preferences based on TNP is presented in table (7) for five group of farmers i. e. A(10000-20000), B(20000-22000), C(22000-23000), D(23000-25000) and E(25000-26000), the average absolute risk aversion (R_a) coefficient is low (0.012) for farmers group E and high (0.139) for group A (10000-20000).

- Gradual increase in Ra as the TNP decreases, this suggest the farmers exhibiting DARA (decreasing absolute risk aversion),
- Down side risk coefficient D_a coefficient is low for group C and higher for group A.
- Observed PRP values for group A, is more compared to group E, hence the farmers in group A shall be given more benefits like subsidy scheme and encourage in farming when compared to group E farmers.
- Unlike the econometric approach, using a minimum amount of data the methodology employed allows the risk aversion coefficients to be calculated,
- In our case, the PRP have been estimated taking into account both objectives and their weights considered by agricultural producers and experts in the field, as the MCDM paradigm proposes. This approach closer to the actual decision-making process in farming.

8. CONCLUSIONS

The purpose of this paper is to provide a tool to analyse the risk for different (paddy) agricultural producers based on their wealth. This paper presents a methodology based on Multiple Criteria Mathematical Programming to obtain Absolute Risk aversion coefficients, absolute Downside Risk Aversion Coefficient and Proportional Risk Premium.

The Novel contribution of this work is its concentration on the assessment of risk aversion coefficients and Downside risk averse coefficients for individual farmers, linking classical EUT with MCDM Paradigm and attempting to integrate the analysis that the decision-making process of the farmers may take into account and to find Proportional risk premium. It can be extended to other farming areas and other agents of the supply chain. The risk premium can be applied in devising various government policies which benefit farmers.

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